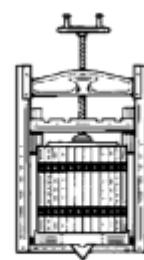


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Optimizing the Use of Groundwater Nitrogen for Nut Crops

David R. Smart¹, Patrick H. Brown²,
Thomas Harter & Jan Hopmans



¹Dept of Viticulture & Enology

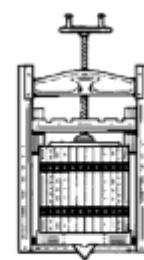
²Dept of Plant Sciences

³Dept of Land, Air & Water Resources

University of California, Davis

Climate Change • Sustainable Farming
Environmental Quality • Remote Sensing

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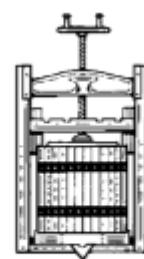
Acknowledgements

**Fertilizer Research and Education Program
California Pistachio Research Board
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N-Supply

N-Demand

N-Loss

Cover crops,
manures,
composts



Irrigation
water



Commercial
N fertilizers

Foliars



Harvested nuts and
husks exported



Leaves and prunings
returned to orchard floor

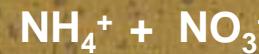


Volatilization,
denitrification
from soil



Organic matter

Mineralized N in soil

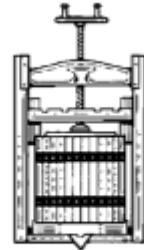


Leaching

Optimize

Synchronize

Minimize



Treatments:

Advanced Grower Practice (AGP)

(split applications targeted to N demand)

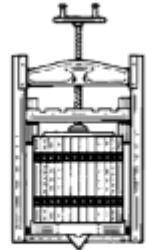
High Frequency Low [N] (HFLC)

("spoon feed", 20 split applications of 5-15 lbs acre⁻¹ N)

Pump and Fertilize (P&F)

(AGP, compensating for well water N loads)

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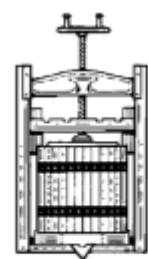


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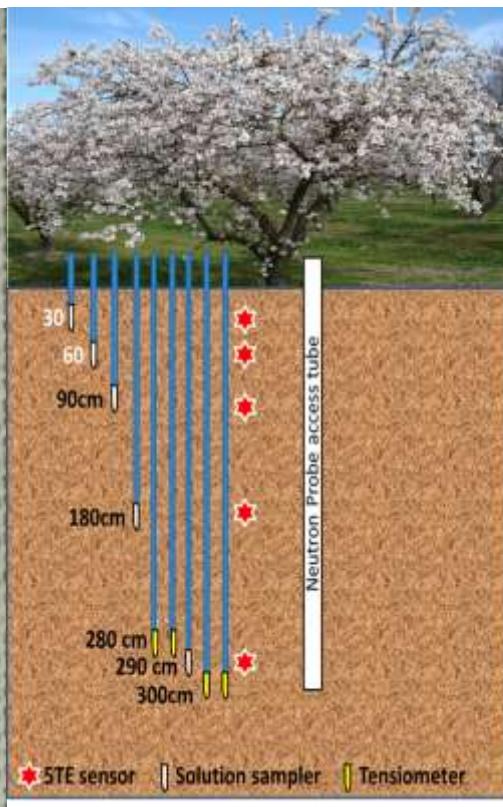
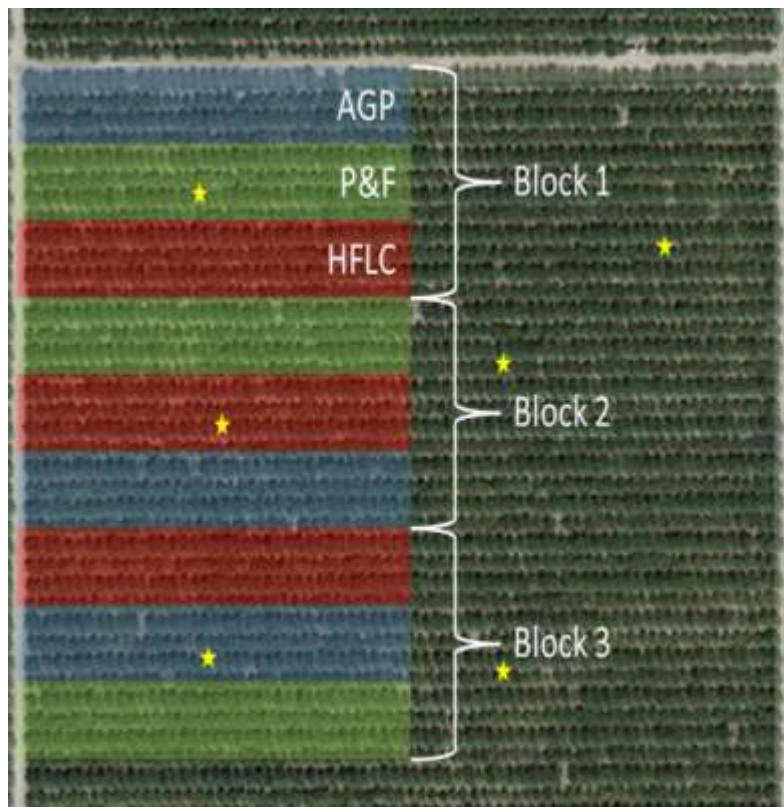


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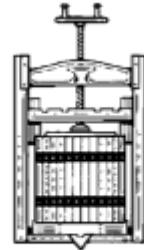


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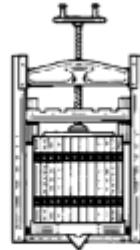
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Agricultural Nitrogen Use Efficiency ANUE

$$\frac{(\text{Harvested N-Outputs}) - (\text{Reactive N mobilization})}{\text{Total N-Inputs}}$$

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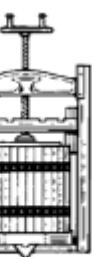
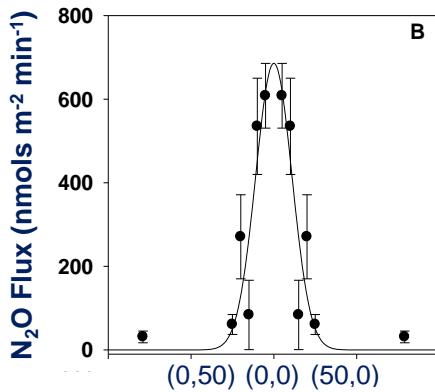
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	Almond (lb/acre)			Pistachio (lb/acre)		
	AGP	HFLC	P&F	AGP	HFLC	P&F
Yield (kernels)	2699	2869	2695	2837	2869	2668
Groundwater-N	73.8	73.8	73.8	14.3	14.3	14.3
Fertilizer-N	215	215	186	174	166	161
Compost-N*	2	2	2	2	2	2
Kernel-N	119	130	112	79	80	75
Storage-N (wood)	25	25	25	25	25	25
N in Hulls	67	72	67	5	5	5
NUE	0.73	0.78	0.78	0.58	0.61	0.58

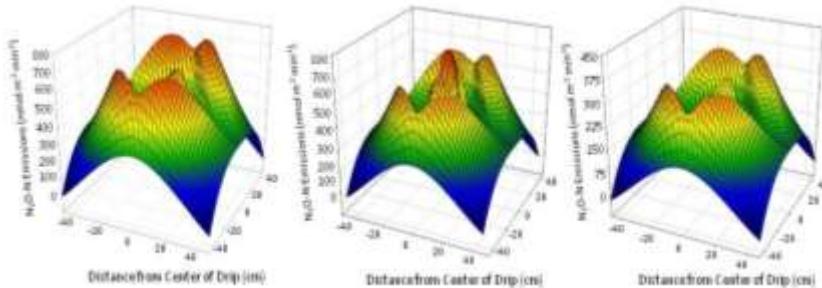
* assumes 5% of 40 lb N in compost available as NH_4^+ and NO_3^-

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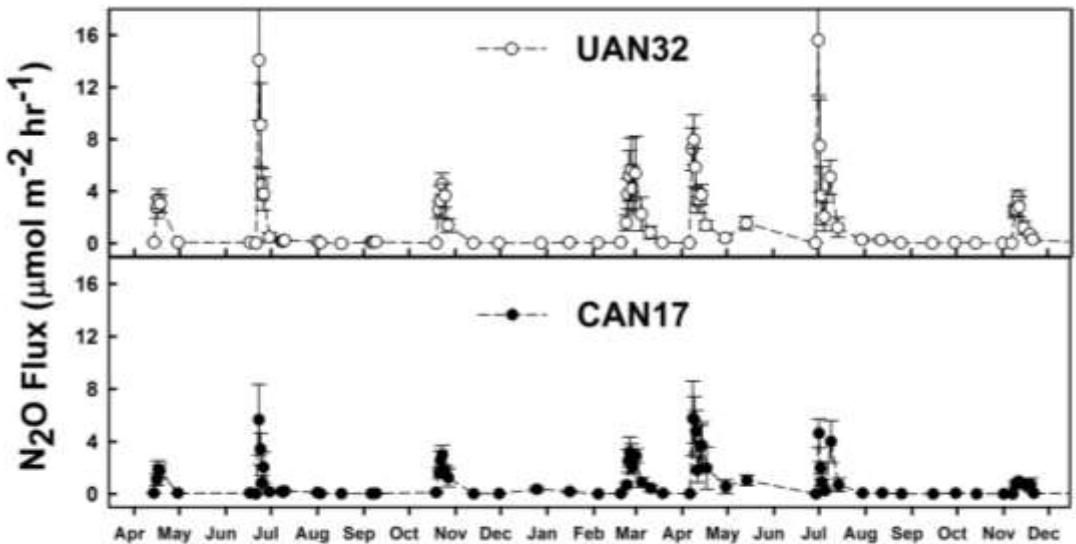
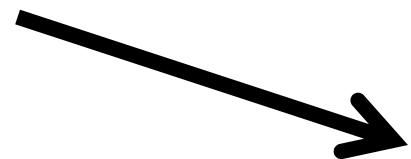
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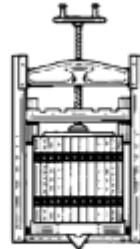
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$$\iint_A f(x,y) dx dy \approx \sum_{x=-0.5}^{0.5} \sum_{y=-0.5}^{0.5} y_0 + e^{\frac{1}{2} \left[\frac{(x-x_0)^2}{b^2} + \frac{(y-y_0)^2}{c^2} \right]}$$



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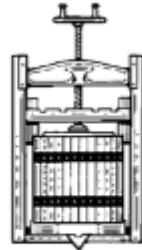
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N in Hulls	67	72	67	5	5	5
N₂O-N loss	0.092	0.036	0.084	0.092	0.036	0.084
NUE	0.73	0.78	0.78	0.58	0.61	0.58

* assumes 5% of 40 lb N in compost available as NH₄⁺ and NO₃⁻

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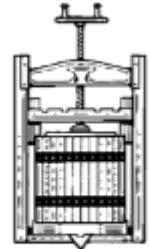


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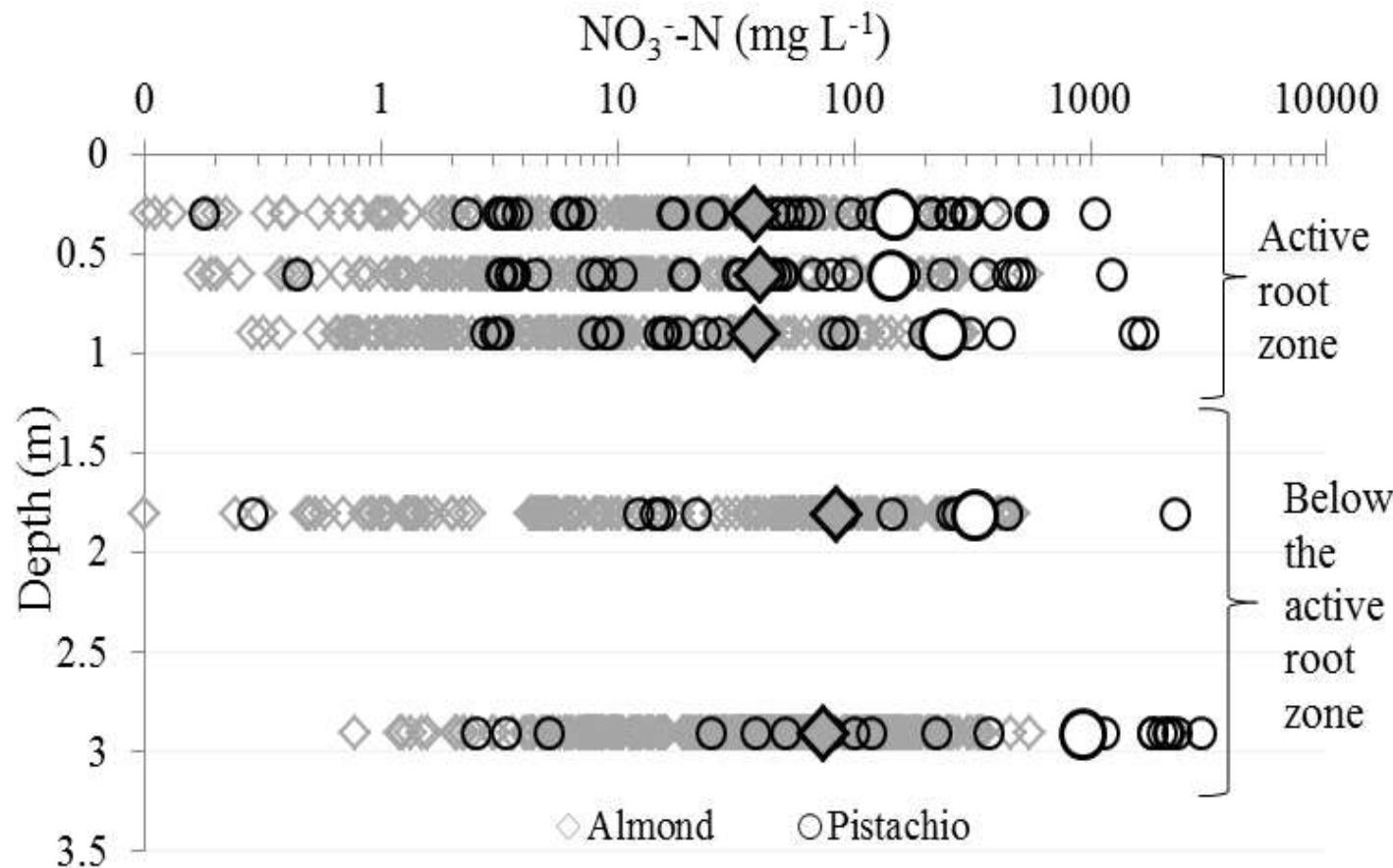
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Kernel-N	119	130	112	79	80	75
Storage-N (wood)	25	25	25	25	25	25
N in Hulls	67	72	67	5	5	5
N₂O-N loss (CO₂ eq)	27.6	10.8	25.2	27.6	10.8	25.2
NUE	0.55	0.62	0.59	0.43	0.55	0.45

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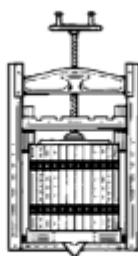


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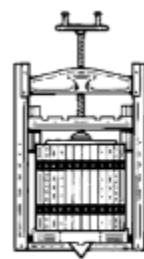


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N in Hulls	67	72	67	5	5	5
N₂O-N loss (CO₂ eq)	27.6	10.8	25.2	27.6	10.8	25.2
NO₃-N (0-1.3 m)	19	11	11.7	19	11	11.7
NUE	0.5	0.71	0.64	0.37	0.48	0.38

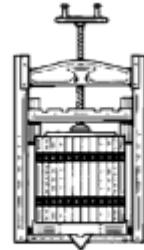
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N in Hulls	67	72	67	5	5	5
N₂O-N loss (CO₂ eq)	27.6	10.8	25.2	27.6	10.8	25.2
NO₃-N (0-1.3 m)	19	11	11.7	19	11	11.7
NO₃-N (1.3-3.0 m)	197.3	144.3	56.7	na	na	na
NUE	-0.18	0.21	0.42	na	na	na



Conclusions:

- 1) There were no detectable deleterious effects on production between AGP, HFLC and P&F and therefore supports the hypothesis that a lb of N in well water acts like a lb of synthetic N fertilizer.
- 2) Only the HFLC N application treatment diminished emissions of the greenhouse gas N_2O . When factored into NUE calculations, showed slightly superior NUE.
- 3) The P&F treatment seemed to diminish potential leachable NO_3^-N below the rooting zone but this result will require further analysis because of extreme heterogeneity.